On Knowledge Representation issues

Alex Abramovich
webdao@yahoo.com

ABSTRACT

Knowledge Representations issues take on special significance in the light of development of the novel Web's reality that involves the Semantic Web, GRID, P2P and other today's ITs. In contrast to the previous IT evolution's stages, the recent one utilizes ontology as separated resource. An elaborate knowledge representation approach implies an efficiency of knowledge-based systems and their interoperability. This paper deals with Ontology Engineering approach that allows both build and generate the consistent dynamic autonomous knowledge-based systems.

Keywords: *Knowledge Representations (KR), reasoning, human activity, domain world, private world, ontology*

1. Introduction

Range of Knowledge Representations' issues, include, but are not limited to:

1. measure of KR approach's adequacy to the represented knowledge
2. measure of knowledge role with respect to the goal that is trying to be achieved
3. measure of overall quality of knowledge within the knowledge representation
4. measure of knowledge uncertainty for the knowledge utilization by the autonomous system
5. measure of the consistency of knowledge that is provided by the autonomous software agents or by the service providers
6. measure of the ontologies' role in autonomous systems

Proceeding from the assumption that human behavior is defined by his knowledge, we have a right to expect a successful evolution of autonomous systems only under the stipulation that it exists a reliable KR foundation.
Unfortunately, underdetermined system of KR's terminology itself produces numerous problematical KR approaches.
In this paper we will attempt to look at aforesaid KR issues as at reasoning's problems and to subordinate knowledge representation to reasoning one.

1.1 What do we mean by knowledge

In order to assess which types of knowledge representation are appropriate for which type of information, including corresponding performance measures as well as to consider other KR issues, it is necessary to define what we mean by knowledge.
Consider some knowledge definitions from Google:
The act or state of knowing; clear perception of fact, truth, or duty; certain apprehension; familiar cognizance; cognition.
"Knowledge, which is the highest degree of the speculative faculties, consists in the perception of the truth of affirmative or negative propositions." *Locke.*
That which is or may be known; the object of an act of knowing; cognition; -- chiefly used in the plural.
"There is a great difference in the delivery of the mathematics, which are the most abstracted of knowledges." *Bacon.* "Knowledges is a term in frequent use by Bacon, and, though now obsolete, should be revived, as without it we are compelled to borrow "cognitions" to express its import." *Sir W. Hamilton.* "To use a word of Bacon's, now unfortunately obsolete, we must determine the relative value of knowledges." *H. Spencer.*
"That familiarity which is gained by actual experience; practical skill; as, a *knowledge* of life. "Shipmen that had knowledge of the sea." *1 Kings ix. 27."*
As we see, knowledge is one of those concepts, concerning which everybody has own opinion. Nevertheless, the last one seems the most operable. Practically, it equates knowledge with an activity representation. In any case, (since the practical skills is used by human in his activity) it means that knowledge is a mental instrument, with is used for the human activity achievement.
Thus it is possible to say that knowledge is an instrument of reasoning.

1.2 Why does a human think?

Before we will define the reasoning model, it is appropriate to put a question – Why does a human think?
"Reasoning is a mediate generalized reflecion of appreciable and regular dependences of reality."[1]
As such it is an instrument of human life cycle providing.
"Thinking and acting are the specific human features of man. They are peculiar to all human beings. They are, beyond membership in the zoological species homo sapiens, the characteristic mark of man as man."[2]

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
AUG 2004		**00-00-2004 to 00-00-2004**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
On Kowledge Representation issues	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **National Institute of Standards and Technology (NIST),Manufacturing Engineering Laboratory,100 Bureau Dr,Gaithersburg,MD,20899**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
Proceedings of the 2004 Performance Metrics for Intelligent Systems Workshop (PerMIS ?04), Gaithersburg, MD on August 24-26 2004

14. ABSTRACT
see report

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**5**	

Since a human life cycle is constituted by set of profession/living activities, reasoning serves these activities' achievement.
At that, knowledge is used as the human activities awareness.
To Ludwig Edler von Mises [2] "human activity is a goal-seeking behavior" and "human action is necessarily always rational".
And so by human activity we mean:

Definition 1. Human activity is time-, place-, state-, and event- ordered set of multidisciplinary actions aimed to achievement of socio-specified goal.

1.3 Activities' types

In spite of the obvious differences of social institutions and persons, their life cycle as set of activities, on closer examination, seems in the following way:

- An activity (activities) that provides the means of subsistence (both profession and other socially specified activities),
- Properly living activities, namely, learning, execution, repair, protection, *an advancement of results*, *supply*, *an analysis and control*.

The first activity (activities) belongs to certain area (areas) of expertise (domain). As domain activities we differentiate *domain generic activities* and *private activities.*
The properly living activities we designated by the common name of *generic living activities.*
Domain generic activity is a basis framework of actions, operations and/or activities aimed to achieve one or more *domain specific goals*, where domain goal is a socio-claimed product or service.
Private activity is an adapted domain/living generic activity provided by a social unit, where by *a social unit* we mean a government, an enterprise, a community and a person.
Thus we differentiate the following activity's types: generic living activities, domain generic activities, and private activities.

1.4 A human mental activity

Now, there is time for *correlate with each* other a social unit's life cycle, activities, knowledge and reasoning:

Definition 2. Reasoning is a human mental activity that operates with human activities knowledge for the purpose of the social unit's life cycle providing.

At that, on the *level of the social unit's life cycle organization* reasoning operates with activities as with data type, and on the *level of the activities' implementation* it operates with an activity's components (see below) as with data types.

It is important to note that reasoning trace is a certain algorithm, and its data types' names constitute *a reasoning ontology*.
We differentiate life cycle of domain (*domain world*) and life cycle of a social unit (*private world*).
Reasoning's algorithm of domain world we denominate as *domain world activity*, and, analogously, reasoning's algorithm of private world we denominate as *private world activity*.
We emphasize the domain world activity and the private world activity, since, as a matter of fact, they define *behavioral/management models* of domain or of a social unit.

Definition 3.

a) Domain world activity (Adw) is a resultant activity of the domain community, composed of domain generic activities (owned by domain experts) and private activities (owned by the other domain community's members), aimed to the domain life cycle providing;
b) Private world activity (Apw) is a resultant activity of the private profession/living activities, owned by social unit and aimed to the private life cycle providing.

2. THE Reasoning

The suggested Ontology Engineering approach forms a core of THE (Total Human Experience) Web project. In the network of THE Web project it is proposed to build an integrated Web knowledge resource (THE KB) with the purpose of the exhaustive Web service providing of the profession/living activities. THE Web service will be realized by an integrated multi-agent system (THE MAS) under multilevel dispatching.
THE KB is constituted by human activities' representation and derived ontological as well as causal environment.
Human Activity is represented in form of Activity Proposition (AP) on the Reasoning Language (RL). RL is THE Web's internal language that data types are represented by Core Ontology (CO), *Domain Ontology (DO) (as CO* extension), Private activity's ontology (PO) as a certain DO extension, Domain World Activity's Ontology (DWO) as DO extension, Private World Activity's Ontology (PWO) as CO and a certain DOs extension that are derived from corresponding activities' propositions (see below).
AP represents an algorithm of the activity performance' steady states transformation. So called Steady Reasoning (SR) serves (validates and directs) this algorithm performance. SR operates the following knowledge types:

- A private activity's *initial state* (AIS)
- A state *transforming* private activity (STA)

- Set of *possible STA effect* states as result of STA,

where a state knowledge includes

- a state ontology,
- a state determinant,
- determinants of state's components;

and a private activity knowledge includes

- an activity ontology,
- an activity's states,
- an instrumental private activities toolkit and
- an activity's determinant.

At that, an activity's and activity state's determinant is a semantic framework of its ontology's components that is a mandatory for inheritance at all generations.

RL provides also transient reasoning's means for the purpose of Transient Reasoning (TR) achievement. In addition to above mentioned, TR operates the following knowledge types, derived from THE KB:

- Network of generalized causalities,
- Generalized cause (that is, set of causes that derive from the same state the same effect),
- Causality determinant.

RL is interpreted by THE MAS reasoning framework (THE Reasoning).

THE Reasoning process is provided by the following agents:

1. *Recognizer* that recognizes determinants of activities and activities' components,
2. *Executor* that executes the AP's sequence of operations,
3. *Predictor* that predicts an eventual course of events,
4. *Reason _detector* that detects a reason of deviation from the specified steady state and generates a target setting,
5. *Activity_generator* that derives from the KB a new activity proposition as a discovered (or received) problem solving.

3. Activity Proposition

This paper is not RL presentation. Therefore we will consider RL features that concern Knowledge Representations issues only. RL is a procedural, a markup, an ontology language as well as an action language, destined for the description of reasoning that required for the activities' performance.

As a procedural language it allows to describe an activity's algorithm.

As an action language it represents a causality in the form of a triplet {I,C,E}, where I is an initial condition, C is a cause, E is an effect.

As an ontology language it allows to input both concepts and concepts' relations.

As a markup language it provides a semantic marking of AP text that allows the ontology mapping.

Activity Proposition plays a part of a canned program and at the same time it is considered as knowledge module. At once on completion of AP design, it occupies THE KB position in compliance with its causal interpretation.

At that, it is necessary to note that we extend concept of an activity actor beyond the social units. We mean by Activity Proposition (AP) a semantically marked description of *purposeful system of operations that producible by human(s) and/or by service provider(s) and/or by apparatus(es) and /or by software applications.*

At that,

- *Activity's ontology* is AP text's remainder of deletion both RL's terms and lexical forms as well as semantic tags (that is, a semantic ordered set of words (*ontology units*) used for AP representation).
- *Ontology unit's semantics* is fixed by the nearest semantic tags (opening and closing) and
- *Ontology unit's meaning* is Web, THE Web or private resource.

3.1. Personal world

Private world (PW) is constituted by set of actual private profession/living (p/l) activities derived from Basis and Domain generic activities. At that, ever it remains the PW composition, namely, *learning, practice (*that is, an execution of a socially specified activity(ies) that provide(s) the livelihood), *repair, protection, an advancement of results, supply, an analysis and management*.

Every p/l activity is correlated with others by time, by place, by preferences and by cost. Space of correlated p/l activities is rank-ordered by APpw that represents a scenario of parallel/sequential executable private p/l activities, which are marked by a special set of tags. RL keeps *AP special sets of semantic tags* that define an activity's position in the personal world. APpw provides a semantic sharing of private p/l activities as well as of private p/l ontology. Private world's activity represented by APpw is aimed to the achievement of it's owner p/l goals with a cost minimization.

A priority of APpw's performance produces *a particular causal stipulation* of private activities as well as *particular reasons of response* to external occurrences (*a private logic*). A corresponding APpw ontology has, therefore, *private semantic features.*

A private logic induces interoperability issues both on the profession and on the living level that must be considered as an operation problems both of PW management and of PWs interaction. In case that a

response to an external occurrence is not contradict APpw performance's logic it will be executed. If not, a response's execution will hurt the PW.
The response's motivation takes on special significance for reasoning, particularly, for Reason _detector and Activity_generator.

3.2 Domain world

Domain world (DW) is constituted both by domain generative activities and by private activities of professional communities, of enterprises and of specialists. THE Web engine keeps *AP special sets semantic tags* that define a profession position of all domain world participants. A corresponding domain world AP (*APdw*) provides a semantic sharing of domain activities as well as of domain ontology.
Domain world activity, represented by APdw, is aimed to the achievement of domain socioeconomic, sociopolitical and socio-productive goals with cost minimization. APdw performance is achieved via domain Web portal.

3.3. THE self-organization

Ontology constitutes the external level of human experience's knowledge representation. Every Onto-unit has THE KB's multi-semantic position represented by set of DW related triplets (APdwName, APName, SemanticTag) as well as by PW related triplets (APpw, APName, SemanticTag). At that every Onto-unitName is accomponied by links to DOName or CO (that is, to Onto-unit parent's name).
This Ontology organization grounds an opportunity of the interoperability issues' solving.
Recognition of an activity's determinant in the current input activates THE Reasoning process.

3.3.1 Target setting's processing

A target setting as an output of Reason_detector or due to a customer's initiative is sent to Activity_generator in form of an initial and a finite state.
Using knowledge of activities states' determinants, Activity_generator search the corresponding THE KB nodes and AP paths between them.
The next problem is a correction of one of this paths with the purpose of utilization it by PW owner.
This correction is a type of a semantic translation that represents a sequential revision of the inter-tags' spaces.
An impossibility of the inter-tags' spaces filling is fixed as a problem that involves a target setting for Activity_generator.
As result of this recursive procedure is a new AP.

4. Measure of KR approach's adequacy to the represented knowledge

Suggested Ontology Engineering approach deals with unified model of above mentioned knowledge types (see paragraph "THE Reasoning") representation. AP representations of existing software tools/agents/applications utilization's procedures will extend THE KB. Representations ones will be used as procedures of access to these resources. In the same way it represented an implement's, an apparatus', equipment's, a sensor's (and so on) utilization as an activity states' components representations. At that, principles of operation of above-named devices are represented by means APs too.

Thus THE Web operates with active knowledge forms, for which AP representation is adequately.

5. Measure of knowledge role with respect to the goal that is trying to be achieved

According to M. Polanyi [3], the components of an optimally organized system must not be further partible in the certain, defined for this system, ratio. M. Polanyi made out of a system's components at a ratio of their contributions to the goal achievement. A component's position in the system's organization defines its semantics. Its contribution defines the component's significance.
Due to RL notation, semantic tags define an ontology unit's contribution to the AP, and an ontology unit is utilized as a pointer of a related resource that details an access procedure (or this knowledge principle of operation). Thus THE KB represents knowledge system, ordered in M.Polanyi sense, and THE KR approach provides a contribution of every knowledge unit to the goal's achievement.

6. Measure of overall quality of knowledge within the knowledge representation

Since an ontological design is provided by domain expert or by APpw owner, the overall quality of knowledge within the knowledge representation is depended on its author's skill level or on the APpw owner's preferences that always may be submit for consideration of new customer. THE engine provides the AP designers' rating and chooses (in the presence of choice) the best AP version.

7. The ontologies' role in autonomous systems

Among a manifold of an ontology definitions the Protégé' one is the most close to RL notation:
"Ontologies are explicit specifications of the types of resources that exist and possible relationships between them, and specific instances of concepts in the ontologies" (http://protege.stanford.edu/).
THE Reasoning utilizes an ontology as a semantically ordered set of Web resources' pointers. Similarly, a human operates on concepts. At that, as concepts it is used both scientific/technical/common terms and arbitrary identifiers of arbitrary objects sets as well as of various process' parts, of states, of situations and so on.

Therefore in THE notation the problem of primary importance is *a reconstruction of the individual conceptual system* (that is, the private ontology mining). A discovery of corresponding DO/CO terms grounds a semantic translation of private situation to the DO/CO specification. Only after that it is possible generating for customer a personalized Web service. Remind that in the previous chapters we considered an ontology as data type names' space. Thus, since reasoning process is grounded by conceptual schemes, an ontology plays a part of primary importance for all knowledge based systems include autonomous ones.

8. Conclusion

We considered a particular Knowledge Representations' approach. We simplified a problem by consideration unified KR form called Activity Proposition. We consider that it optimally satisfies both human and machinable reasoning and that in such a way we are able to build of a personalized Web service.

Reference:

[1] "Reasoning is a mediate generalized reflecion of appreciable and regular dependences of reality." (http://azps.ru/articles/proc/proc9.html)
[2] Ludwig Edler von Mises, "*Human Action: A Treatise on Economics*",The Foundation for Economic Education, Inc. Fourth revised ed., 1996, printed 1998
[3] M. Polanyi, Personal Knowledge, Harper & Row, New York, 1958